

Cardiopulmonary Resuscitation in a University Hospital

An Analysis of Survival and Cost

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A cost analysis and study were done of patient survival after in-hospital cardiopulmonary resuscitation during one year at a university hospital. The immediate survival rate in 128 patients was 52 percent. Survival to discharge and six-month survival rates were 19 percent and 15.6 percent, respectively. In all, 23 patients (18 percent) had multiple arrests (two to four per patient) during the same hospital stay. Immediate and six-month survival rates in this group were 52 percent (12 patients) and 9 percent (two patients), respectively. Gender or location where cardiopulmonary arrests occurred in the hospital did not influence survival. The cost of a Code Blue (direct expenses only) was \$366. We conclude that the outcome following resuscitation at this university hospital compares favorably with the experience of others, and that the direct cost is modest in relation to the results obtained.

EFFECTIVE CARDIOPULMONARY RESUSCITATION (CPR) has been of particular concern in university teaching hospitals because the *Code Blue* (CB) team members change frequently and consist of house staff at different training levels. Patients with multisystem disease who require specialized medical care further complicate this situation.

Studies of survival of patients who underwent CPR for cardiopulmonary arrest (CPA) occurring before admittance to hospital have been published^{1,2} with follow-up of six months and longer.³

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Follow-up beyond two months⁴ of patients surviving in-hospital CPA has not been reported since the early study of Lemire and Johnson.⁵

Although the immediate survival rate following CPR was reported 17 years ago by members of the staff at this institution,^{6,7} no systematic evaluation of cost and longer-term survival has ever been undertaken.

Coskey recently reviewed the favorable experience with CPR in a community hospital. The purpose of this study was to assess the overall effectiveness of CPR at a large university hospital.

Methods

The patients at this institution are referred by physicians and clinics serving our metropolitan

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ABBREVIATIONS USED IN TEXT

CB=Code Blue
CPA=cardiopulmonary arrest
CPR=cardiopulmonary resuscitation

Percentages are relative to the total number of patients (128)

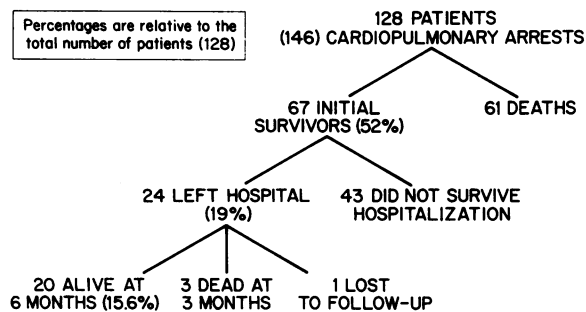


Figure 1.—Survival following cardiopulmonary arrests.

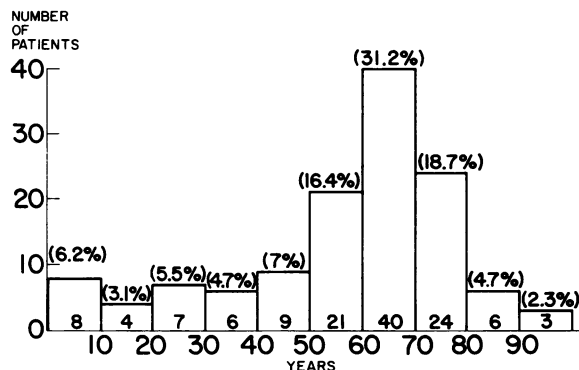


Figure 2.—Age distribution of patients suffering cardiopulmonary arrests.

area and state. The hospital has 560 inpatient beds.

The CB team consists of a medical, a surgical and an anesthesiology resident; a respiratory therapist; a pharmacist; a nurse, and a pediatric resident when necessary. All members carry voice-page beepers which are simultaneously triggered by the telephone operator when a CB is reported. Formal training and certification in CPR were introduced as mandatory requirements in this hospital at the end of 1977. Therefore, the CPR experience of the residents involved with the CB team during this study is indeterminate and probably variable.

Patients were identified through CB report forms completed by the medical resident on the CB team. The locations and times of the events were obtained through the page operator and each CB counterchecked from the reports. The authenticity

TABLE 1.—Patient Survival by Gender

	Men		Women	
	Number	(Percent)	Number	(Percent)
Immediate survivors ..	32	(48)	35	(56)
Deaths	34	(52)	27	(44)
TOTAL	66		62	

Chi square=0.81
P=0.37

TABLE 2.—Patient Survival by Service

	Surgical Service		Medical Service	
	Number	(Percent)	Number	(Percent)
Immediate survivors ..	10	(31)	57	(59)
Deaths	22	(69)	39	(41)
TOTAL	32		96	

Chi square=7.61
P=<0.01

of each cardiopulmonary arrest was verified by both CB report and chart review.

Arrests were not included in this study if a CB report was not completed or if the telephone operator was not notified. CB patients were excluded from the analysis if they did not have documented evidence of CPA as defined by Jude, Kouwenhoven and Knickerbocker.⁸ During the time of the study, the University of California had a *no code* policy for certain categories of patients. No patient in this study fell into the *no code* group.

Follow-up of patients was done by reviewing the charts of those patients remaining within the university clinic system and by telephone contact with the referring physicians for those patients referred to the University.

A patient was considered a survivor at follow-up if his or her levels of consciousness and physical activity were similar to those before admittance to hospital. Patients in whom arrest occurred before arrival at the hospital were excluded from the study. All the Emergency Department CPR's included in the study were *de novo* arrests occurring while the patients were in that department.

Results

During 1977, there were 147 CB's involving 129 patients at this institution. This number has remained relatively constant during the last three years, when between 130 and 135 CB's per year have been reported. One CB called was not considered to have been a CPA and was therefore eliminated from the analysis. In 23 patients (18

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TABLE 3.—Immediate Patient Survival by Month

Month	Number of Patients	Number of Code Blues	Immediate Survivors Number (Percent)
January	11	11	4 (36)
February	9	12	3 (33)
March	11	13	8 (73)
April	9	9	5 (56)
May	11	12	5 (45)
June	9	9	6 (67)
July	14	19	3 (21)
August	11	13	8 (73)
September	12	14	8 (67)
October	6	6	1 (17)
November	15	16	10 (67)
December	10	12	6 (60)

TABLE 4.—Distribution of Cardiopulmonary Arrests by Location

Location	Number	Percent
Intensive care unit	33	26
Cardiac care unit	15	12
Emergency department	9	7
Hospital floors	57	44
Others	14	11

TABLE 5.—Immediate Survival of Patients by Location

Location	Number/Total	Percent
Intensive care unit	19/33	58
Cardiac care unit	7/15	47
Emergency department	5/9	56
X-ray department	4/5	80
Hospital floors	32/57	56
Miscellaneous areas	4/9	44

percent), more than one arrest occurred, with a maximum of four arrests. All multiple arrests occurred during the same hospital stay, generally within the same 24-hour period. Of the 23 patients with multiple arrests, 12 (52 percent) survived. Two are alive at six months' follow-up (8.6 percent).

Of the 128 patients (Figure 1), 67 (52 percent) survived. Of these survivors, 24 (19 percent) were discharged from the hospital functioning at the same level of activity as before CPA. One patient was lost to follow-up. Three patients died after three months, and 20 (15.6 percent) were alive six months after CPA. Of these 20 patients, five have survived 15 months after arrest, eight have survived 9 months and seven have survived 6 months.

Age distribution of patients is shown in Figure 2. Modal age of the group was 60 to 69 years, and 66.4 percent of the patients were 50 to 80 years old. Sex distribution is shown in Table 1. No relationship between survival and gender was noted. Of the patients, 75 percent were on the Medical Service and 25 percent on the Surgical Service. Of the 20 survivors at six months, 2 were surgical patients, and 18 were medical. Among surgical patients, the immediate survival rate was 31 percent, whereas in the medical group it was 59 percent (Table 2).

Of the CB's, 48 (38 percent) occurred in either

TABLE 6.—Code Blue Costs*

Equipment		
Monitor and defibrillator \$3,500 × 40 units	= \$140,000	
Portable suction \$161 × 40 units	= 6,400	
Crash cart \$650 × 40 units	= 26,000	
	\$172,440	\$34,488†
Code Blue Committee (yearly)		
Ten members—two hours per month × 12 at \$20 per hour	= \$ 4,800	
Secretarial time—100 hours × \$6.50 per hour	= 650	
	\$ 5,450	\$ 5,450
Variable Charges		
Drugs	\$ 50.00	
Ancillary floor charges	20.00	
Physicians' and nurses' labor†		
MD's—\$9.40 per hour (three house staff)	14.10	
RN's—\$8.50 per hour (two nurses)	8.50	
	\$ 92.60 × 146	\$13,520
Total direct costs	=	\$53,458
Cost per Code Blue	=	\$ 366

*Excludes any training.

†Five year depreciation.

‡Rates based on a 30-minute resuscitation effort.

the Intensive Care Unit (ICU) or the Cardiac Care Unit (CCU). The immediate survival rate of patients was 56 percent and the six-month survival rate was 8 percent. Distribution of CB's and immediate survival by month is shown in Table 3. Distribution of CB's by location is summarized in Table 4 and immediate survival by location is shown in Table 5. No significant differences were noted, even when widely separated locations were compared.

We were unable to determine CB team response time, but a survey of the nursing staff failed to show any instances where the CB team had been delayed. CPR was routinely started by the ward staff before the team's arrival, which may have contributed to the favorable outcome of the resuscitation. Any criticisms that resulted generally related to the overabundance of medical staff whose presence often hindered the efforts of the CB team.

Cost Analysis

The cost analysis was based on current replacement costs for equipment used in CPR, CB Committee time and other variable charges as summarized in Table 6. Our variable charge was based on a 30-minute resuscitation effort which represents the average for most cases in our study and others. Our direct cost per CPR is \$366.

We contacted various general hospitals in the area to determine what charges if any were ever billed in the event of a CPR. Five of the hospitals that answered had no such charge. One charged \$40, another charged \$98 in the Emergency Department and \$124 in the hospital; yet another charged \$85. Our hospital had a \$120 charge for the Emergency Department only.

Discussion

This study's findings should allay apprehensions of house staff and attending staff regarding the performance of the CB team. Their effectiveness is substantiated by a success rate greater than 50 percent that was documented regardless of whether the arrest occurred in a CCU-ICU setting or elsewhere in the hospital.

Resuscitative efforts are usually more aggressive in teaching hospitals. In view of this fact, the discharge rate from this hospital (19 percent) and six-month survival rate (15 percent) are surprisingly high. Earlier studies have given discharge rates between 8 percent and 25 percent^{1,5,9-12} in university hospitals. More recent

studies have reported much lower rates (3 percent to 5 percent).^{4,13} Community hospital studies uniformly have reported a higher immediate survival and hospital discharge rate (15 percent to 30 percent).¹⁴⁻¹⁹

The favorable results reported by community hospitals may be attributed to increased selectivity in resuscitative efforts by physicians more familiar with patients' situations and to the complexity of illness in university hospital patients. Our initial survival rate is similar to reported rates for the last 18 years.^{1,5,9-12} A three-year follow-up of patients in the 1960's showed a significantly lower death rate beyond six months and an almost static death curve beyond one year.⁵ One community hospital study reported 89 percent survival 9 to 42 months postarrest.¹⁶

As reported in previous studies, ventricular standstill is associated with the poorest prognosis (no survivors out of seven cases).¹¹ Patients with preexisting chronic obstructive lung disease are also in a poor prognostic category;¹¹ one of four patients in this category survived in this series.

Most of the surgical patients were in hospital after either open-heart or intra-abdominal operations, whereas the medical patients represented a wide spectrum of disease. We are unable to explain the statistically significant difference in immediate survival between surgical and medical patients; previous studies shed little light on this observation.⁹ Almost certainly, underlying disease is an important factor; however, further investigation is necessary to define the determinants of survival after CPA. It is of interest that most studies report very similar short-term and long-term survival rates when comparing cardiac patients with or without acute myocardial infarction with other types of medical and surgical patients undergoing CPR.^{9-11,20}

Our only criticism concerns poor record-keeping of CB events, which makes data retrieval extremely difficult. A detailed form and plan for data retrieval has been devised by Peschin and Coakley.¹³ Implementation of such a plan requires a firm commitment from all members of the Code Blue team.

Most hospitals, including the University of California, San Francisco, do not charge for CPR. This may be due to the sensitivity of the issue and the difficulty of identifying the cost of resuscitations. The data presented here may serve as a guideline for instituting such a charge.

The CB team's performance should be periodi-

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cally monitored to insure continued effectiveness, even though we were unable to detect any differences during the year attributable to level of training.

We conclude that this university hospital's experience with cardiopulmonary resuscitation compares favorably with other institutions.

REFERENCES

1. Eliastam M, Duralde T, Schwartz F, et al: Cardiac arrest in the Emergency Medical Service system: Guidelines for resuscitation. *JACEP* 6:525-529, 1977
2. Baum RS, Alvarez H III, Cobb LS: Survival after resuscitation from out-of-hospital ventricular fibrillation. *Circulation* 50:1231-1234, 1975
3. Lewis AJ, Bebout C, Ailshie GE: Long-term survival fibrillation, abstracted. *Circulation* 46(supplement 2):60, 1972
4. Messert B, Quagliari CE: Cardiopulmonary resuscitation: Perspectives and problems. *Lancet* 2:410-411, 1976
5. Lemire JG, Johnson AL: Is cardiac resuscitation worthwhile?—A decade of experience. *N Engl J Med* 286:970-972, 1972
6. Rivkin LM, Roe BB, Gardner RE: Cardiac resuscitation through the intact chest. *Calif Med* 96:75-79, 1962
7. Rivkin LM, Roe BB, Gardner RE: Closed chest cardiac resuscitation. *Am J Surg* 104:283-291, 1962
8. Jude JR, Kouwenhoven WB, Knickerbocker GG: External cardiac resuscitation. *Monogr Surg Sci* 1:59-117, 1964
9. Wildsmith JAW, Dennyson WG, Myers KW: Results of resuscitation following cardiac arrest—A review from a major teaching hospital. *Br J Anaesth* 44:717-719, 1972
10. Kennelly BM: Analysis of a 2 year-old resuscitation service. *Resuscitation* 3:229-239, 1974
11. Castagna J, Weil MH, Shubin H: Factors determining survival in patients with cardiac arrest. *Chest* 65:527-529, 1974
12. Jung MA, Selby A, Johnson JR, et al: Value of a cardiac arrest team in a university hospital: Results in a series of 100 patients. *Canad Med Assoc J* 98:74-78, 1968
13. Peschin A, Coakley CS: A five-year review of 734 cardiopulmonary arrests. *South Med J* 63:506-510, 1970
14. Dykema ML, Vasu CM: Cardiopulmonary resuscitation in a community hospital—A one-year experience. *Mich Med* 72:469-472, 1973
15. Beaven WE: External cardiac resuscitation—Experience in a community hospital emergency department. *NY State J Med* 73:1810-1814, 1973
16. Jeresaty RM, Godar TJ, Liss JP: External cardiac resuscitation in a community hospital—A three-year experience. *Arch Intern Med* 124:588-592, 1969
17. Coskey RL: A resuscitation program in a community hospital—Five-year experience. *Geriatrics* 26:66-72, 1971
18. Polta TA: Cardiopulmonary resuscitation at McKennon Hospital. *South Dakota J Med* 26:38-43, May 1973
19. Kaunitz VH, Trivedi JM: Cardiopulmonary resuscitation in community hospital. *NY State J Med* 72:2751-2752, 1972
20. Coskey RL: Cardiopulmonary resuscitation: Impact on hospital mortality—A ten-year study (Health Care Delivery). *West J Med* 129:511-517, Dec 1978